ASSESSMENT OF YIELD LOSSES DUE TO RICE SHEATH BLIGHT AT DIFFERENT INOCULATION STAGES [1]

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Introduction

Assessment of yield losses due to plant diseases can be made by establishing a direct relationship between degrees of infection, stages of plant growth and yield loss. In this way, information on the amount of yield reduction by a given stage of crop development can be obtained. Such estimates of loss can serve as bases for determining economical investments in control measures and for deciding which among the available control measures to apply.

Various methods of obtaining an objective estimate of loss have previously been devised. Greaney (1933) estimated losses in yield from cereal diseases by correlating percentage of infection and yield in a single variety. Similar method was used by Jennings (1963) on hoja blanca disease of rice and Mathur et al. (1964) on paddy blast. Rangaswami (1957) worked on losses of neck blast based on the weights of infected and healthy grain yields. Padmanabhan (1965) indicated several techniques such as comparison of crop yields in non-epidemic and epidemic areas, comparison of yield of susceptible and resistant varieties of the same yield potential, use of varieties of same yield but resistant or susceptible at different stages of growth, comparison of yield of plots protected by fungicides, and weighting healthy and diseased tillers.

In Japan, about 120,000 to 190,000 hectares have been reported to be infected and a loss of 24,000 to 38,000 tons of rice each year has been estimated in recent years (National Institute of Agricultural Sciences, Japan, 1954). Mizuta (1956) estimated that a 20 percent reduction in yield may occur if the disease developed up to the flag leaf. Hori (1969) also reported that 25 percent loss in yield when the disease reached the uppermost flag leaves. There was a close correlation between the percentage of diseased hills in a field and the yield loss. Fungicidal treatment increased the yield by 1.6 percent when 5 percent of the hills were infected, by 6.4 to 7.1 percent when 50 percent were infected, and by 8.9 to 10.1 percent when 100 percent were infected. The disease was very common in the Philippines, where it caused severe damage in certain fields in some seasons (Ou, 1972).

Assessment of yield loss due to rice blast and bacterial leaf streak in the Philippines

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were reported by Exconde et al. (1970) and Opina et al. (1971). But no assessment of yield loss due to sheath blight was reported.

The objective of this experiment was to determine the yield loss caused by sheath blight at different stages of growth and the relationship of disease index and yield loss among them, and provided a sound basis for controlling the disease.

Materials and Methods

Planting and care of plant An early maturing variety IR833-6-2-1-1 was selected for this experiment. The seeds were pre-germinated on the filter papers in the petri dishes for 3 days. Then four seedlings were transplanted to each of the big pot (40 cm in diameter, 32 cm in height). Five replicates and seven treatments were designed. Loss in yield was estimated at six different stages of inoculation.

The experimental plants were given proper agronomic care to ensure good yield. One gram of nitrogen from ammonium sulfate (21%) was applied per pot at seeding and panicle initiation period, respectively. Furadan granule was applied at the rate of 1 g/pot every month to control insects.

Inoculation Inoculation was done at 15, 30, 45, and 60 days after seeding and at booting and milk stages, individually. Rice straw inocula were inserted in the tillers at the base of the rice plants and wrapped with paper towels. At the 15 days after seeding inoculation, the rice straw inocula were placed at the base of the seedlings and covered with paper towels to keep the moisture. Ten days after inoculation the paper towels were removed.

Yield loss data When 85 to 95 percent of the grains were riped, the panicles were harvested. After threshing, the grains were sun-dried for 1 week. Yield losses of experimental plant with varying stages of inocuation were determined by weighing the grains and comparing them with the yield of the control.

In order to compare the disease indices, the test plants were investigated 10 days before harvesting. Disease index was obtained by dividing the number of infected leaf sheaths with the total number of leaf sheaths and multiplying the quotient by 100.

Results and Discussions

Some of the seedlings were killed by the fungus 20 days after inoculation which were inoculated at 15 days after seeding. If the seedlings were not dead, they might recover afterwards. Ten days after inoculation at the other stages, the mycelium spread upward and damaged the leaves or leaf sheaths of the plants. The disease indices and yield data were shown in Tables 1 and 2, respectively. After statistical analysis, the results were shown in Tables 4 and 5. From Table 4, it indicated that the differences in indices of different treatments were highly significant. And from Table 5 it showed that A, B and C were not significant, but they were significant with the other treatments. In case of D and E, they were not significant between each other, but they were significant with the other treatments. While F and G were significant with each other and also with the other

treatments. It also showed that the highest disease indices were obtained at maximum tille-ring and booting stages. This suggested that for varietal screening resistance to sheath blight inoculation can be done at both stages. Many workers have reported that the disease was especially destructive under conditions of high humidity and high temperature. While the temperature within the rice crop varied with that of the air temperature, humidity among the plants was greatly affected by the thickness of the stand, so that close planting and heavy application of fertilizer, leading to thick growth, tend to increasing disease incidence. For the same reason the disease was usually observed in the field after the plants have reached the maximum tillering stage, when high humidity tends to be maintained within the microclimate (Ou, 1972). This statement could corroborate that high disease indices were obtained at D and E stages, because during those stages the plants have reached maximum tillering stage.

Yield and yield losses were shown in Tables 2 and 3, respectively. After statistical analysis, the treatments showed significant differences (Tables 4 and 5). Table 5 showed that yield and yield losses were correlated with disease indices at A, B, C, D, and E stages. But they were not correlated between F and G stages. This showed that at milk stage inocuation, the yield loss was not significant, though the disease index was high. This may be partly explained that this stage the plants may have already enough food for grain development. And the flag leaves have not been seriously impaired by the disease.

Statistical analysis showed that the yield of A, B, and C stages did not differ much but significant with the other treatments. It was not significant between D and E, but significant with the others. Also F and G were not significant, but they were significant with the others. While in case of percentage of yield losses, it showed the same trend with grain yields.

Quantitative and qualitative losses relatively from infection of rice by *Helminthosporium oryzae* were most severe when rice was inoculated in the flowering and milk stages (Fazli et al., 1966). But in neck and node blast, the incidence was directly associated with the yield because most of the grains did not fill up, the panicles dropped over with the weight of the few grains that did fill up, resulting in partial to total loss of the crop (Mathur et al., 1964). In case of rice tungro disease, the yield loss due to tungro was determined by susceptibility of rice variety and plant age at the time of infection. For instance, in greenhouse experiments when IR 8 plants were inoculated at 15, 30, 45, 60 and 75 days after sowing the yield reduction was 68, 57, 30, 16, and 7 percent, respectively. In contrast, for IR 9—60, and experimental selection, the yield reduction was 74, 55, 50, and 32 percent when inoculated at 15, 30, 45, and 60 days after sowing, respectively. The yield was not significantly affected when plants were inoculated at 90 days (Ling, 1972). Therefore, higher yield reduction was obtained at early stage of inoculation for virus disease and lower reduction at later stages. In this experiment, it also showed that at milk stage inoculation, the yield was not significantly reduced compared to control(without inoculation) although the disease index was significantly to control.

Summary

Yield losses in IR 833-6-2-1-1 (an early maturing variety) due to sheath blight were studied at six stages of inoculation. A reduction in yield was 7.95, 7.15, 6.05, 10.78, 11.73, and 1.85% at 15, 30, 45, 60 days after seeding, at booting stage, and milk stage, respectively. The yield and yield loss were compatible with disease index at 15, 30, 45, 60 days after seeding and at booting stage. The reduction in yield was highly significant.

Literature Cited

1. EXCONDE, O. R. and A. D. RAYMUNDO. 1970. Further study on the assessment of yield losses due to rice blast. Philippine Phytopathology 6 : 66—74.
2. FAZLI, S. F. T. and H. W. SCROEDER. 1966. Effect of kernel infection on rice by *Helminthosporium oryzae* on yield and quality. Phytopathology 56 : 1003—1005.
3. GREANEY, F. J. 1933. Method of estimating loss in yield from cereal diseases. Phytopathology 23 : 12.
4. HORI, M. 1969. On forecasting the damage due to sheath blight of rice plants and the critical point for judging the necessity of chemical control of the disease. Rev. Pl. Prot. Res. 2 : 70—73.
5. JENNINGS, P. R. 1963. Estimating yield loss in rice caused by hoja blanca. Phytopathology 53 : 492.
6. LING, K. C. 1972. Rice virus diseases, IRRI symp. proceedings, 134 p.
7. MIZUTA, H. 1956. On the relation between yield and inoculation times of sheath blight, *Corticium sasakii* in the earlier planted paddy rice. Ass. Pl. Prot. Kyushu 2 : 100—102.
8. MATHUR, R. S., G. K. BAJPAI., L. S. CHACHAN and S. C. VERMA. 1964. Assessment of loss caused by paddy blast. Plant Dis. Reptr. 48 : 711—713.
9. NATIONAL INSTITUTE OF AGRICULTURAL SCIENCES, JAPAN. 1954. Insects and diseases of rice plant in Japan. Paper presented at the 4th session, Int. Rice Comm., Tokyo, 33 p.
10. OPINA, O. S. and O. R. EXCONDE. 1971. Assessment of yield loss due to bacterial leaf streak of rice. Philippine Phytopathology 7 : 35—39.
11. Ou, S. H. 1972. Rice Diseases. Common. Mycol. Inst. Kew, Surrey, England. 368 p.
12. PADMANABHAN, S. Y. 1965. Estimating losses from rice blast in India. p. 205—221. In Rice Blast Disease. Johns Hopkins Press, Baltimore, Md. 507 p.
13. RANGASWAMI, G. and T. V. SUBRAMANIAN. 1957. Estimation of loss due to blast disease of rice. Sci. and Cult. 23 : 192—203.

Table 1. Disease indices at different stages of inoculation (%) .

Treatment	Replication				
	1	2	3	4	5
A a/	50.03	59.01	50.19	41.85	54.00
B	50.26	58.43	53.85	50.16	47.50
C	54.51	58.67	68.98	47.99	60.14
D	88.58	82.82	84.13	80.22	86.89
E	84.04	73.52	71.15	81.10	91.03
F	59.95	72.19	68.59	66.75	73.97
G	0	0	0	0	0

a/ A—Inoculation at 15 days after seeding.
B—Inoculation at 30 days after seeding.
C—Inoculation at 45 days after seeding.
D—Inoculation at 60 days after seeding.
E—Inoculation at booting stage.
F—Inoculation at milk stage.
G—Control.

Table 2. Weights of 1000 grains (gram) .

Treatment	Replication		
	1	2	3
Inoculation at :			
A. 15 days after seeding	28.90	30.51	31.08
B : 30 days after seeding	29.85	30.42	30.98
C. 45 days after seeding	30.65	31.40	30.25
D. 60 days after seeding	28.55	29.70	29.42
E. booting stage	28.30	28.45	30.02
F. milk stage	31.83	31.87	32.75
G. Control	31.98	32.90	33.40

Table 3. Yield loss at different stages of inoculation (%).

Treatment	Replication		
	1	2	3
Inoculation at :			
A. 15 days after seeding	9.63	7.26	6.95
B : 30 days after seeding	6.66	7.54	7.25
C. 45 days after seeding	4.16	4.56	9.43
D. 60 days after seeding	10.72	9.72	11.91
E. booting stage	11.51	13.53	10.12
F. milk stage	0.47	3.13	1.95
G. Control	0	0	0

Table 4. Analysis of variance.

SV	Disease index (%)		Yield (g/1000 grains)		Yield loss (%)	
	df	MS	df	MS	df	MS
Replicate	4	41.26	2	0.73	2	2.27
Treatment	6	3929.88**	6	54.14**	6	6.01**
Error	24	31.12	12	2.53	12	0.29
Total	34	—	20	—	20	—
CV %		9.9		5.19		1.76

**Significant at 1% level.

Table 5. Table of means.a/

Treatment	Disease index (%)	Yield (g/1000 grains)	Yield loss (%)
Inoculation at :			
A. 15 days after seeding	51.02 b	30.16 bc	7.95 b
B. 30 days after seeding	52.04 b	30.42 b	7.15 b
C. 45 days after seeding	58.06 b	30.77 b	6.05 b
D. 60 days after seeding	84.53 d	29.22 cd	10.78 c
E. booting stage	80.17 d	28.92 d	11.73 c
F. milk stage	68.29 c	32.15 a	1.85 a
G. Control	0.00 a	32.76 a	0.00 a
LSD 5%	7.29	0.95	2.68

a/ Any two means under the same character followed by the same letter were not significantly different at 5% level, using LSD.

水稻在不同接種時期對紋枯病之產量損失估計

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中 文 摘 要

本報告爲水稻品種ＩＲ 833—６—２—１—１（早熟品種）在六個不同接種時期對紋枯病的產量損失估計之研究。水稻在移植後 15天，30天，45天，60天，孕穗期及乳熟期接種的減產各爲 7.95，7.15，6.05，10.78，11.73及1.85%，其產量、產量損失與發病率的關係，除乳熟期接種者外，其餘在移植後15天，30天，45天，60天及孕穗期接種者均頗一致。水稻由紋枯病而引起的產量損失爲極顯著。